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The influence of socioeconomic factors on storm preparedness and experienced impacts in Finland

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A R T I C L E I N F O

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A B S T R A C T

Extreme weather events, such as storms, may cause material damage, injuries, and interfere with day-to-day operation of societies. Earlier research on natural hazards and climate change adaptation has found that demographic and socioeconomic factors influence the way individuals prepare for and are affected by natural hazards. However, research often focuses on areas with high exposure and vulnerability and research on low exposure and vulnerability areas is scarcer. To address this gap, we ask: do socioeconomic and demographic factors matter in how individuals prepare for and are affected by storms in Finland? Our data consist of an internet survey (n = 1014) conducted after a severe winter storm hit Finland in the beginning of 2019, and we analyze the data with Chi-squared tests and logistic regressions. Our results show that respondents' education level or employment status are not connected to whether they took preparedness measures or whether they experienced harm. Instead, the type of residential property does play a part. In addition, respondents who had experienced storm-related harm during recent years are more likely to prepare than those who have not. In conclusion, socio-demographic factors seem to have only marginal influence on storm preparedness or experienced impacts in Finland, which contradicts earlier research. This may stem from the relatively equal distribution of well-being among the population.

1. Introduction

Individual adaptation to climate change remains understudied, despite of its importance being frequently recognized in public adaptation plans [1]. Moreover, disaster preparedness is increasingly becoming the responsibility of individual citizens and households [2,3]. Individuals and households will need to adapt to changes in the reliability of electricity, transport and telecommunication infrastructure, cost of food, and rising insurance premiums, as well as psychological stress and substantial systemic changes [4]. We define a disaster as a severe alteration in the normal functioning of a community, due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse effects (adapted from Ref. [5]: 558), and hazard as an occurrence of a physical event that may cause injury or damage (adapted from Ref. [5]: 560).

The concepts of individual adaptation to climate change and individual disaster preparedness are closely connected. On the one hand, preparedness has been defined as "the knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters" [6]; 21). Martins et al. [7]; 316) define household preparedness as a "set of pre-event actions that are developed to increase the social ability to respond to natural or man-made hazards". Specific preparedness measures often considered in the literature include e.g., emergency food and water supply, as well as heating equipment [8], but also knowledge and practical experience, such as having an emergency response plan and participation in evacuation drills [9].

On the other hand, individual adaptation to climate change may appear very similar. Van Valkengoed and Steg [10] discuss adaptation behaviours ranging from immediate emergency responses, such as evacuation to preparedness measures and acquiring a home emergency supply kit to long-term adaptation, such as supporting climate adaptation policies. Likewise, González-Riancho, Gerkensmeier, and Ratter [11] consider *community preparedness* and *long-term adaptation* as associated constructs. The main difference is that preparedness is used widely in the context of disaster risk management, and it can be used in terms of any risk or threat, including climate-related hazards. In this

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study, household and individual preparedness for natural disasters are considered as a part of societal adaptation to climate change.

Earlier research on disaster risk management and climate change adaptation has found that there are number of factors that influence how an individual prepares for and is affected by natural disasters. These range from individual level factors, such as age and education level [12,13] and previous experience [14,15] to factors that emerge as a result of social relations. It is also well-known that vulnerability is context-specific, since the distribution of the effects of natural hazards does not follow the same principles across societies [16,17].

While these factors underlying individual adaptation are quite well known, research has often focused on areas with high exposure and vulnerability, and research on low exposure and vulnerability countries is scarce [4,18]. It is well known that vulnerability is dynamic and scale-dependent, and societies or individuals with perceived high capacities may not take action [19,20]. Previous research in the Nordic context has focused on institutional analyses [21], with less focus on actors in adaptation [22].

To address this gap, the objective of this study is to examine how socioeconomic and demographic factors are connected to individuals' storm experiences in Finland. We pose five hypotheses in Section 2 that examine whether demographic and socioeconomic factors have an effect on if an individual receives prior information of storm, if they prepare for it, and if they experience harm or damage.

2. Background and hypotheses

The academic literature that explains individual level vulnerability to natural hazards and coping capacity has drawn on several sources, including adaptation to climate change [23] and household disaster preparedness [24]. There are a number of factors that influence how an individual prepares for and copes with natural disasters, such as extreme weather events, such as level of education and previous experience, to factors that are emerge as a result of social relations, such as community networks. We identify three broad factor categories that are likely to affect an individual's preparedness: (1) social vulnerability (made up of demographic and socio-economic determinants), (2) the place and type of residence, and (3) previous experience.

2.1. Social vulnerability

Vulnerability is defined as the "potential to be harmed" [25], or "the state of susceptibility to harm from exposure to stresses - - and from the absence of capacity to adapt" [26]. Determinants of vulnerability have been discussed in the literature in detail [25,27] and they are largely agreed upon, while disagreements exist on choosing the representative variables, as they are often found to be context-specific [12,13].

Most commonly, these include different demographic and socioeconomic factors that influence the way individuals are affected by natural hazards. Socioeconomic factors contribute to greater vulnerability of some population subgroups, and as a result they are likely to suffer a disproportionate share of the effects of hazardous events [28]. Social vulnerability can be seen to stem from lack of assets (including knowledge), political power, and social networks, as well as beliefs and customs, physical limitations, and quality of infrastructure. In particular, people with lower education and income, people who lack social capital and networks, unemployed and elderly are more vulnerable to natural hazards [12].

Age, gender and ethnicity are often considered the relevant demographic determinants of vulnerability. First, most vulnerable age groups are the very young and the very old, due to mobility constraints that restrict moving out of harm's way [12]. Elderly people in particular are highly vulnerable to hazards such as heatwaves [1] and floods [16] due to e.g., impaired mobility, isolation, and poor access to healthcare services [29]. In addition, the elderly are less likely to prepare for disasters [1,7]. However, the elderly may have more experience and knowledge of natural disasters [30], and some studies have concluded that younger people less likely to prepare for disasters [8]. While children are vulnerable, community networks brought together by schools can advance recovery after disasters [31].

Gender as a determinant is more complicated. On the one hand, women are generally perceived as being more vulnerable to disasters due to lower income level and more family care responsibilities [12]. On the other hand, it has been noted that women have generally stronger social networks [27] and are more likely to have high education than men in many countries [16,17]. Men tend to have lower risk perception [15,32] and are less likely to prepare for disasters [8], although their self-efficacy is higher [32]. Nevertheless, Rufat et al. [27] state that the differences within genders are often higher than differences between genders; therefore, gender rarely is an essential vulnerability determinant.

Ethnicity is often considered relevant in North American context, and it is linked to power relations and income level [12]. Studies conducted in European context sometimes take account of foreigners and immigrants, as they are often less active in civil society organizations relevant in disaster preparedness [30], and language barrier hinders access to information [16]. Some have also made a distinction between western and non-western foreigners [17].

Determinants linked to the socio-economic status of the individual, such as family size, income level, education and social capital, are considered important. On the one hand, a high number of small children or other dependents in a family is linked to increased vulnerability [12]. On the other hand, small households often have potentially limited resources to prepare [16], and people who live alone tend to be less prepared [30]. Also, single parents are considered vulnerable to natural disasters [7].

Income level is considered particularly relevant [33], as even relatively small economic losses can have grave consequences, especially if one cannot afford new property or an insurance [12,16]. Low income is also linked to lower likelihood of preparing for disasters [7]. In addition, unemployment is often cited as a determinant of vulnerability [12,16,17,27,28]. Low education level is also connected to low income [12]. It increases vulnerability to disasters [16]. It limits access to information and the means to understand it [12] and is connected to lower likelihood to prepare [8].

Finally, social capital enables preparedness and reduces vulnerability. Sometimes social capital is viewed as an individual's attribute, represented by involvement in local social networks (see Ref. [16]. Sometimes it is perceived as a community feature associated with trust and collective action (see Ref. [34]. Informal social networks have been found to be important in response and recovery stages of disaster risk management [35]. Social capital and networks improve access to financial aid, emotional support, shelter, and other kinds of help, while individuals with few social ties receive less assistance and are less likely to evacuate [36]. Living alone is sometimes associated with lower social capital [37], and small households – people living alone, single parents – have potentially limited resources for preparing without external assistance [16].

Based on these earlier studies, we hypothesise that:

H1. Socioeconomic and demographic variables are connected to storm preparedness. Groups that are less likely to receive prior information on the storm and prepare for it include:

(a) people with only basic education
(b) people who are not employed (unemployed, students, pensioners)
(c) people living alone(d) people older than 65 years of age

2.2. Place and type of residence

The ability and need to adapt are also dependent on an individual's place and type of residence. Two specific, interlinked issues are identified as important when it comes to the individual's actions, the type of dwelling and neighborhood characteristics.

First, people in apartment buildings have found to be less likely to prepare for disasters [8]. Larger apartments and detached houses are associated with financial resources [30]. Renting indicates vulnerability because tenants are less likely to invest in built-in preparedness measures, e.g., flood protection [16]. While expensive home equals high potential losses, valuable houses are typically more resilient to hazards than less valuable ones [12].

Second, geographical and neighborhood characteristics are relevant. In particular, urban and rural dwellers have different vulnerabilities. On the one hand, residents of rural areas often see themselves well prepared because they know their neighbors and their resources, as well as the geography and infrastructure of the area [2]. At the same time, residents of rural areas tend to be more isolated, older and have lower education level than people in cities. Many rural sources of livelihood, such as the primary sector, are vulnerable to natural hazards [12]. In Finnish rural areas, electricity is often distributed through overhead power lines exposed to falling trees [38]: 16), but rural residents are more likely to have access to alternative heating systems and neighbor assistance [39]. On the other hand, urban residents tend to have higher level of education and better access to services and information, but also more loose-knit communities, more fragmented social environment, and interdependent infrastructure and services [40]. Moreover, densely populated areas are more difficult to evacuate [12]. Regarding climate change adaptation, cities are regarded as more self-sufficient, as they often account for their own adaptation planning, whereas rural areas rely more on state support [41].

Based on this, we pose the following hypothesis:

H2. Dwelling type and the rural-urban divide are connected to preparedness and experienced harm or damage.

a) People living in urban areas and apartment buildings are less likely to prepare than people in rural areas and detached houses
b) People living in people in urban areas and apartment buildings are less likely to experience storm-related harm or damage than people in rural areas and detached houses

2.3. Previous experience

Previous experience of disasters has also been shown to be significant in terms of preparedness. Experiencing a disaster may make the risk seem more personal and tangible [42] and hence lead to higher risk perception [15] and preparedness [8,43]. Correspondingly, not having earlier disaster experience has been linked to passive behavior in early warning situations [44]. In addition, vicarious experience and even following the media coverage of a disaster are observed to have similar effects as first-hand experience [14,45]. However, while earlier disaster experience shapes risk perception, it does not always translate into taking preparedness measures [14]. Lin et al. [46] discovered that victims of natural disasters are less willing to adopt risk mitigation measures than the rest of the public, despite their higher risk perception. Especially traumatic experience of a disaster is connected to a low level of psychological preparedness [47] and low likelihood of taking preparedness measures [42]. Furthermore, certain cognitive biases have been identified to explain why disaster experience may lead to relatively low level of preparedness. These include normalization bias, meaning that an individual who survives one disaster can cope with future events as well, and gambler's fallacy, i.e., thinking that after one disaster the next one is unlikely to happen soon [14].

Based on this, we pose the following two hypotheses:

H3. People who have no earlier experience of storm-caused impacts are less likely to prepare

H4. People who do not receive prior information on the storm are less likely to prepare.

3. Materials and methods

3.1. Case: A winter storm in Finland

A severe winter storm named Aapeli in Finnish and Alfrida in Swedish hit Northern Europe in the beginning of 2019. On January 2nd, wind speed reached 32.5 m/s – highest ever recorded in Finland. 120,000 households suffered from power outages and municipal rescue departments received 700 emergency tasks. Yet, the storm was anticipated: the Finnish Meteorological Institute already issued warnings five days prior to the storm [48].

The region most affected by the storm in Finland was Ostrobothnia [48], located on the western coast of the country (Fig. 1). According to Statistics Finland [49]; Ostrobothnia's degree of urbanization is slightly lower than the national average: 57% of the population live in urban or semiurban areas (country average 61%). Out of Finnish regions, Ostrobothnia has the highest employment rate (73.4%, whole country 68.6%) and slightly larger than average household size (2.2, whole country 2.0). Swedish is an official minority language in Finland spoken by 5% of the population, but in Ostrobothnia, no less than 50% of the population speaks Swedish as their first language [50].

Finland and the rest of the Nordic countries are relatively equal and wealthy democracies and have low vulnerability and high adaptive capacity [20]. Finland's economic capacity is slightly lower than its neighbor Norway's, but its social and administrative capacity are high [51]. However, inequalities exist in Nordic countries too; for instance, there are income-related health differences in Finland [52]. Besides, regional differences are prominent: the population is increasingly concentrated in the southern part of the country, and western Finland is more prosperous and healthier than eastern Finland. Rural areas close to cities often thrive, but sparsely populated rural areas struggle, and urban areas are diverse in terms of well-being [53].

Finland faces few serious natural hazards, but climate change is likely to increase the risk and impact of extreme weather events [54]. The magnitude and frequency of floods will change, and the risk of forest fires will increase. There is an indication of storms becoming more frequent and intense, and storm-caused damage is estimated to increase [54]. Although wind speeds observed in the Nordic countries are modest in global comparison, modern Nordic societies are dependent on electricity, and storms can have prominent consequences. Storm damage is often assessed in terms of forest damage, property damage, cost for insurance companies, number of tasks for rescue services, and the number of households without electricity [55]. On the other hand, people in northern latitudes are already facing challenging conditions due to the current climate [20]; lack disasters results also from good governance and technology [18].

In conclusion, vulnerability determinants in Nordic countries are likely to differ from the global average, especially areas with higher exposure and vulnerability. However, differences in well-being exist in prosperous countries as well [52], and the impact of socio-economic factors on vulnerability to disasters has been observed e.g., in Canada [33].

3.2. Survey

The Finnish National Rescue Association and the Finnish Meteorological Institute conducted an internet survey immediately after the storm (9th-16th January 2019). The survey was targeted to people living in Finland and included questions on whether respondents had received

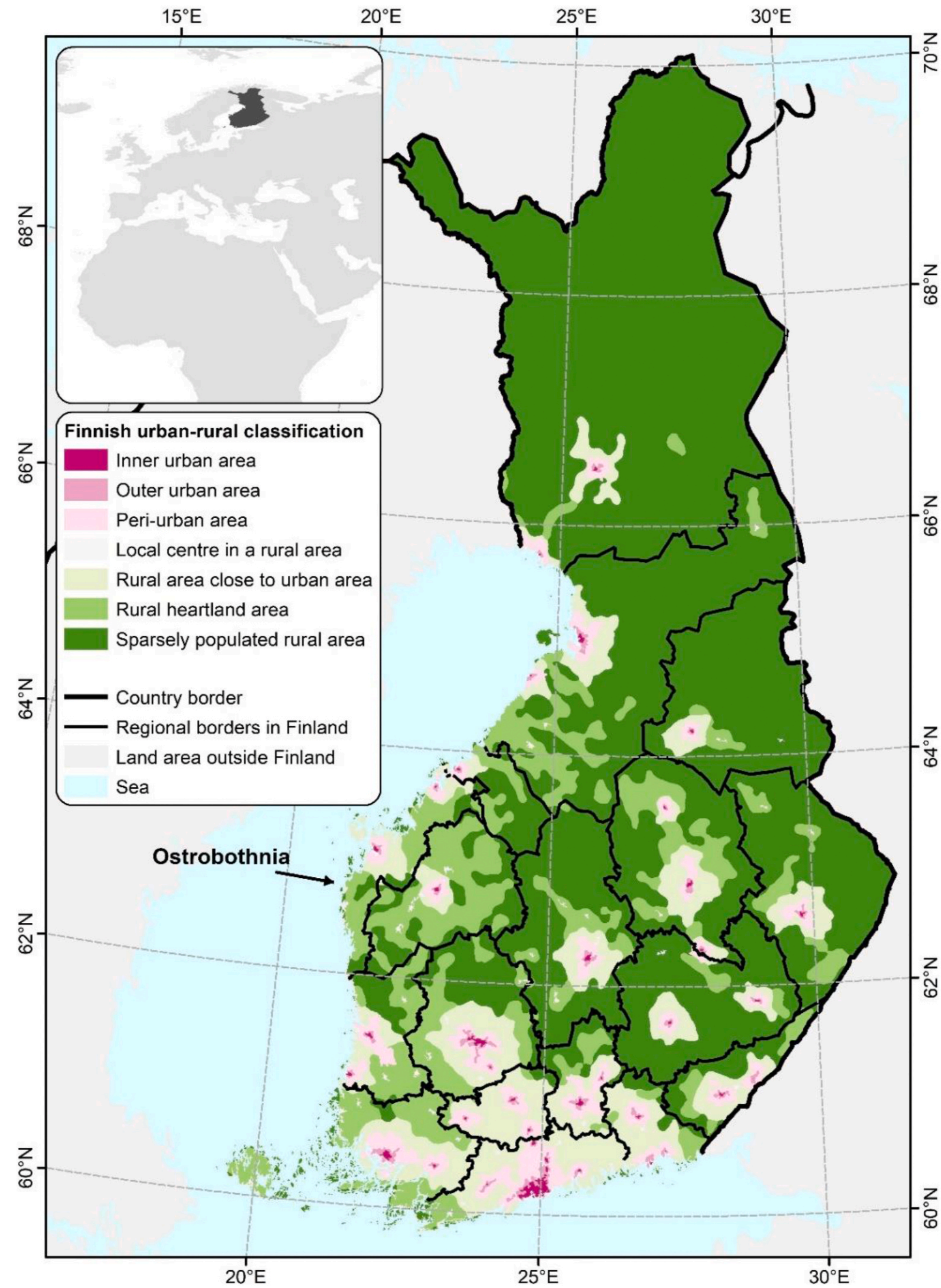

Fig. 1. Location of Ostrobothnia and the Finnish urban-rural classification [19].

prior information on the storm, the preparedness measures they took, possible harm caused by the storm, and respondents' earlier experiences of storms. The survey also included questions that were not used in this study, regarding e.g., whether the respondents called the emergency response centre because of the storm, what kind of help they received and from whom, and to what extent they trust the Finnish Meteorological Institute's weather forecasts. The survey was available in Finnish and in Swedish, the two official languages in Finland. In total, 1014 responses were collected.

We chose three dependent variables from the survey questions: prior information on the storm, preparedness, and experienced harm or damage (Table 1). Prior information was a binary variable: either it was received or not. Preparedness was measured through a list of possible preparedness measures. We constructed a binary variable so that selecting one or more of these was considered as being prepared. Experienced harm or damage was measured in a similar way: the survey included a list of possible types of harm and damage, and if a respondent reported experiencing one or more of them, they were considered as having experienced harm.

We examined how various independent variables affected the dependent variables (Table 1). In the survey, the respondents were asked about their demographic and socioeconomic characteristics. These were coded as binary variables based on our hypotheses of which population groups might be more vulnerable to storms. We selected and coded respondents over 65 years of age, respondents who lived alone, respondents who were not employed, respondents who lived in Ostrobothnia, and respondents with basic education only. Although gender and language were not expected to influence vulnerability significantly,

Table 1
Independent and dependent variables chosen for this study.

Factor	Question in survey	Response options	Coding	Notes
Demographic variables				
Gender	Gender	Woman, man, other	1 = male 0 = female	Three respondents (0.3%) who picked 'other' were excluded.
Age	Age	under 18, 18–34, 35–44, 45–54, 55–64, 65–74, over 75	1 = younger than 65 0 = 65 or older	
Language	–	Presumed based on whether responded to the Finnish or Swedish version of the survey	1 = Swedish 0 = Finnish	
Household composition	Are you	Couple, couple with children, single parent with child(ren), living alone, living with parents, other	1 = living alone 0 = other	
Socioeconomic variables				
Employment	Are you	Employed, unemployed, student, pensioner, other	1 = employed 0 = other	
Education	Education	Basic education, vocational education, high school graduate, bachelor's degree, master's degree, other	1 = basic education 0 = other	
Region, neighborhood & dwelling variables				
Rural-urban	Area of residence	Urban, semiurban, rural	1 = urban 2 = semiurban 3 = rural	
Dwelling type	Dwelling type	Detached house, row house, apartment building, summer cabin	1 = apartment building 2 = row house 3 = detached house	27 respondents (3.2%) who picked 'summer cabin' were excluded.
Region	Region	Multiple choice with Finland's 19 regions	1 = Ostrobothnia 0 = other	
Earlier experience				
Earlier experience of storm-caused impacts	Which of the most common types of storm-related impacts have affected your daily life the most in recent years?	Multiple choice with 8 types of storm-caused impacts[a], none	1 = one or more forms of impacts reported, 0 = no impacts reported	
Dependent variables				
Prior information	Were you informed of the storm in advance?	Yes/no	1 = yes 0 = no	
Preparedness	Did you prepare for the storm in advance?	Multiple choice with 8 measures[b], other, none	1 = one or more preparedness measures, 0 = no preparedness measures reported	
Harm or damage experienced	What damage or effects did you experience during the storm?	Multiple choice with 7 types of experienced harm/damage[c], other, none	1 = one or more forms of harm/damage, 0 = no harm/damage reported	

[a] Power outages; water outages; road transport is impeded; rail traffic is impeded; waterborne traffic is impeded; forest damaged by snow load; forest damaged by wind; damage to buildings and property.

[b] I cancelled my planned trip; I reserved plenty of extra time for traveling; when traveling or outside, I made sure I was able to find shelter quickly, if needed; I prepared for possible power outages; I moved my belongings from the yard to a shelter; I moved the car to a shelter; I disconnected electrical equipment from the AC power; I warned other people of the storm.

[c] I could not leave the house as planned; my residential property was damaged; a vehicle was damaged; there was personal injury; there was a power failure that caused difficulties; phone did not work; a previously planned trip with a bus, train or ship was canceled.

we included those as well. We also included neighborhood type and dwelling type and coded these on an ordinal scale (Table 1). Finally, respondents were asked if they had experienced storm-caused harm or damage in recent years. Earlier experience of storm impacts was coded as a binary variable.

We cross-tabulated independent variables with dependent variables and conducted Chi-squared tests to estimate the statistical significance of observed differences. We conducted binary logistic regressions for the three dependent variables to discover the most significant determinants for them and used exponentiation of the B-coefficient (odds ratio) to assess how a unit change in the independent variable influences the odds for the dependent variable. P-values were used to estimate the statistical significance. We tested all independent variables and chose the variables to the final model with backward conditional procedure (Table 2). To assess the goodness-of-fit of the models, we used Nagelkerke coefficient of determination (R^2). We conducted statistical analyses in IBM SPSS Statistics 25 (IBM, Armonk, NY, USA).

Table 2
Independent variables included in each logistic regression analyses.

Dependent variable	Prior information	Preparedness	Harm and damage
Independent variables	Gender (male) Age (under 65) Lives alone Language (Swedish) Basic education only Employed Region (Ostrobothnia) Place of residence Dwelling type Earlier experience	Gender (male) Age (under 65) Lives alone Language (Swedish) Basic education only Employed Region (Ostrobothnia) Place of residence Dwelling type Prior information Earlier experience	Gender (male) Age (under 65) Lives alone Language (Swedish) Basic education only Employed Region (Ostrobothnia) Place of residence Dwelling type Prior information Preparedness Earlier experience

4. Results

In total, 844 (83%) people answered the survey in Swedish and 170 (17%) in Finnish. The largest number of responses was collected from western Finland, the area most affected by the storm. Majority of the respondents (712 people, or 71% of all respondents who reported their region of residence) were from the region of Ostrobothnia. Especially the Swedish-speaking respondents were mainly from Ostrobothnia (83.5%), while Finnish-speaking respondents were more evenly distributed (8.9% from Ostrobothnia). Most of the respondents lived in rural areas (65%). The most common dwelling type was a detached house (79%) and the most common level of education was bachelor's degree (35%). The most common age group of respondents was 18–34 (27%). Table 3 shows the results of the cross tabulation and Chi-squared tests.

4.1. Prior information on the storm

In total, 90% of respondents got information of the storm beforehand through media, friends or family. Demographic variables had a connection to whether a respondent received prior information on the storm. According to the cross tabulation and Chi-squared tests (Table 3), women, people who live in row houses and apartments, Ostrobothnia residents, people who live alone, people younger than 65 years and those who answered the survey in Swedish were less likely to receive information of the storm beforehand. Logistic regression (Table 4) produced mostly similar results although its goodness-of-fit was very low (Nagelkerke R^2 0.069); most important determinants of receiving prior information were living in a detached house, living with other people, being over 65 years old, and having Finnish as a language preference.

Table 3
Summary of cross tabulations and Chi-squared tests. Statistically significant ($p < 0.05$) connections are marked with bold text.

	Prior information	Preparedness	Harm/damage
Rural-urban	$\chi2 = 3.397$, p = 0.183	$\chi2 = 2.081$, p = 0.353	$\chi2 = 49.788$, **p = 0.000**
urban	87.3%	59.0%	52.9%
semiurban	92.2%	66.2%	63.0%
rural	89.2%	64.1%	78.6%
Dwelling type	$\chi2 = 8.478$, **p = 0.014**	$\chi2 = 18.097$, **p = 0.000**	$\chi2 = 31.478$, **p = 0.000**
apartment building	84.8%	46.8%	48.1%
row house	82.4%	51.6%	58.2%
detached house	90.9%	66.6%	74.4%
Gender	$\chi2 = 4.810$, **p = 0.028**	$\chi2 = 2.062$, p = 0.357	$\chi2 = 10.399$, **p = 0.001**
woman	87.6%	62.1%	75.8%
man	91.8%	65.0%	66.5%
Age	$\chi2 = 8.145$, **p = 0.004**	$\chi2 = 1.170$, p = 0.279	$\chi2 = 1.081$, p = 0.299
younger than 65	89%	63.0%	75.4%
older than 65	97%	68.0%	70.9%
Education level	$\chi2 = 0.947$, p = 0.330	$\chi2 = 0.516$, p = 0.473	$\chi2 = 0.883$, p = 0.347
basic education	93.0%	59.7%	66.7%
other	89.3%	63.9%	71.9%
Household composition	$\chi2 = 5.890$, **p = 0.015**	$\chi2 = 5.993$, **p = 0.014**	$\chi2 = 4.914$, **p = 0.027**
living alone	83.6%	45.9%	63.4%
other	90.5%	54.1%	72.7%
Employment	$\chi2 = 0.832$, p = 0.362	$\chi2 = 0.638$, p = 0.424	$\chi2 = 2.016$, p = 0.156
employed	89.0%	62.8%	70.1%
other	90.9%	65.5%	74.5%
Language	$\chi2 = 8.634$, **p = 0.003**	$\chi2 = 6.121$, **p = 0.013**	$\chi2 = 23.223$, **p = 0.000**
Swedish	88.3%	62.0%	74.6%
Finnish	95.9%	72.0%	56.2%
Region	$\chi2 = 7.279$, **p = 0.007**	$\chi2 = 2.331$, p = 0.127	$\chi2 = 8.453$, **p = 0.004**
Ostrobothnia	87.9%	62.1%	74.2%
other	93.6%	67.2%	65.1%
Prior information		$\chi2 = 62.740$, **p = 0.000**	$\chi2 = 1.806$, p = 0,108
yes		67.8%	70,9%
no		28.2%	77,1%
Earlier experience	$\chi2 = 2.078$, p = 0.111	$\chi2 = 9.041$, **p = 0.003**	$\chi2 = 32.508$, **p = 0.000**
yes	89,9%	64.9%	73.7%
no	84,5%	47.2%	42.5%

4.2. Preparedness measures taken

In total, 63.6% of the respondents reported having prepared for the storm in some way. Not preparing was often explained in the optional open answers by the fact that the storm was not expected to be very strong, or that the respondent had no particular need to be prepared: for example, they lived in a block of flats, or practiced a high level of everyday preparedness regardless of the weather.

Based on Chi-squared tests (Table 3) and logistic regression analysis (Table 5), receiving prior information of the storm, having earlier experience of storm impacts, dwelling type and Finnish language were linked to increased likelihood of taking preparedness measures. However, the Nagelkerke R^2 was only 0.106, indicating poor model fit. Cross tabulation (Table 3) showed that respondents living in detached houses were more likely to prepare (66.6% did prepare), while about half (51.6%) of respondents living in row houses prepared, and respondents living in apartment buildings were least likely to prepare (46.8%). This result was statistically significant (P = 0.000). It is noteworthy that respondents' education level, employment status, age and gender were not connected to whether they took preparedness measures.

4.3. Experienced harm and damage

Logistic regression (Table 6) had again low goodness-of-fit (Nagelkerke R^2 0.141) and indicated that respondents who had experienced storm-related harm during recent years were more likely to experience it now as well. Respondents living in rural areas and detached houses experienced more harm when compared to respondents living in urban areas and other kinds of dwellings. However, the effect of dwelling type was not quite statistically significant. A statistically significant connection was also found between experienced harm and some demographic variables: women and Swedish-speaking respondents were more likely to experience harm.

According to the cross tabulation and Chi-squared test, respondents living alone were less likely to experience harm (63.4% of them and 72.7% of the others experienced harm, p = 0.027), but this result was not replicated in the logistic regression. In addition, respondents living in Ostrobothnia reported of experienced harm more often than others (74.2% of them and 65.1% of the others, p = 0.004). However, education level, employment status and age had no statistically significant linkage to experienced harm.

Based on the more specific types of experienced harm, power outages and related telephone outages particularly affected the rural areas. Damage to residential property was more common in rural and semi-urban areas and in detached houses. "I couldn't leave home as planned" was a relatively common experienced harm for respondents living in

Table 4
Final logistic regression model on what factors were connected to whether respondents received a prior information of the storm.

Independent variable	B-coefficient	Odds ratio	P-value
Dwelling type	0.410	1.506	0.013
Lives alone	−0.605	0.546	0.036
Age <65	−1.329	0.265	0.011
Language (Swedish)	−1.441	0.237	0.001
Constant	*3.679*	*22.262*	*0.000*

Table 5
Final logistic regression model on what factors were connected to whether respondents prepared for the storm.

Independent variable	B-coefficient	Odds ratio	P-value
Prior information	1.508	4.515	0.000
Earlier experience	0.622	1.862	0.017
Dwelling type	0.457	1.579	0.000
Language (Swedish)	−0.467	0.627	0.022
Constant	*−2.212*	*0.109*	*0.000*

Table 6
Final logistic regression model on what factors were connected to whether respondents experienced harm or damage.

Independent Variable	B-coefficient	Odds ratio	P-value
Earlier experience	1.226	3.406	0.000
Language (Swedish)	0.724	2.063	0.000
Rural-urban	0.429	1.536	0.000
Dwelling type	0.248	1.282	0.077
Gender (male)	−0.490	0.613	0.001
Constant	*−2.282*	*0.102*	*0.000*

apartment buildings.

5. Discussion

Our results show that socioeconomic factors, such as education level and employment status, seem to have marginal influence on how the survey respondents prepared for a winter storm and experienced its impacts. In other words, hypothesis 1 has no support, except for the notion that people living alone were less likely to receive prior information on the storm. Instead, some unpredicted demographic factors, like language, were connected to respondents' storm experiences. On the contrary, hypothesis 2 has partial support: for example, respondents living in detached houses were more likely to prepare for the storm, and those living in a rural area were more likely to experience harm. Also, hypotheses 3 (having earlier experience of storm impacts makes one more likely to prepare) and 4 (receiving prior information on the storm is linked to preparedness) are supported by our data. However, these effects were mostly minor, reflected by the low goodness-of-fit in the logistic regression models and quite low differences in cross tabulation analyses.

Our data suggests that respondents living in detached houses are more likely to prepare than respondents living in row houses or apartment buildings. This is probably connected to the fact that residents in detached houses are often solely responsible for maintaining their own property, and having more property equals more potential losses [12]. Moreover, experiencing storm damage in the past could serve as an incentive to be prepared. In addition, preparing for power outages in apartment buildings is more complicated, as there is often less storage space for emergency kit and extra food supply, no backup source of water or a fireplace.

Respondents in rural areas were more likely to experience harm than those living in urban areas. This reflects the fact that rural areas often have overhead power lines, which are exposed to falling trees, whereas in urban areas power lines are usually located underground [38]: 16). This interpretation is supported by the detailed information of the type of harm experienced: power outages and the related communication network failures particularly affected rural areas, while urban dwellers often reported about not being able to leave the house – perhaps because no more specific damage was experienced. Hence, urban infrastructure may provide a buffer against harm caused by extreme weather events [56]: 7, 18), presumably to a certain point. After all, the storm did not cause a major disruption in urban residents' everyday life. Further research is needed on how urban residents cope in more extreme circumstances, and on how the impacts from other extreme weather events are distributed.

Demographic factors also had some effect on the dependent variables, but not in an obvious way. While gender was not connected to whether respondents took preparedness measures, women were more likely to experience harm. While there is no obvious explanation for this, it is possible that women may report damages more easily. In addition, people over 65 years of age received prior information on the storm more often than others. This could be because those over 65 years of age are more likely to follow the news on television and radio, where storm warnings were given six days prior to the event itself.

The significance of language is surprisingly large. One of our findings was that Swedish speakers experienced more damage than Finnish speakers. Regarding this result, we noticed that almost all of the Swedish-speaking respondents were from western Finland, mainly from the region of Ostrobothnia, which was badly hit by the storm, while Finnish-speaking respondents were more evenly distributed: about half were from the western parts of the country, and the rest were from central, southern or eastern Finland. However, according to the logistic regressions, the significance of language seems to be greater than that of the region of residence. Swedish speakers were also less likely to receive prior information, while living in the most affected area. Perhaps, there is less risk communication aimed at the Swedish-speaking minority. This is interesting, since while Swedish-speakers are a minority in Finland, they are not thought of as a marginalized group – they are generally healthier, live longer and have higher social capital than the Finnish-speaking population [57].

Our results show that education level and employment status had a minimal effect on storm experiences. This could be linked to relative equality of society. Although students, the unemployed and pensioners have lower-than-average income, there is little serious material deprivation or homelessness. In addition, Toole et al. [4] note that the role of education, age, ethnicity and income have a rather complex relationship with adaptation capacity. "Unheralded" adaptation capacities, like frugality and flexibility, can be found especially in low-income households, migrants and the elderly. Likewise, wealthy households with energy-intensive and inflexible lifestyles may be more notably vulnerable. Formal education is not always needed – on a society scale, successful adaptation requires knowledge of climate change impacts and adaptation options, but this is not always true on the household scale: adaptation also occurs unconsciously when coping with daily life in changing circumstances [4].

Another result of this study is that having prior knowledge of the impending storm led to active preparedness only for 68% of the respondents. This supports the observation that receiving information of a risk does not always result in action. Wachinger et al. [45] list three key explanations for why knowledge of risk does not lead to preparedness: firstly, people may be are aware of risks, but choose to accept them. Second, people understand the risks but do not identify themselves as actors: one feels that preparedness belongs to someone else, such as the authorities. Third, people recognize the risks, but do not have resources and knowledge to prepare. Based on the open answers in our survey, not preparing might be the result of all of these – particularly, lack of knowledge, excessive trust in authorities, and fatalism. The division of responsibility regarding disaster risk management has been noted to be vague in Finland: local residents do not consider themselves responsible for it, while authorities call for self-preparedness [35]. Moreover, power outages are not necessarily perceived merely as risks, which threaten property and everyday life: they can also be seen in a positive light, emphasizing community and coping [2,58]. While household-level storm impact mitigation measures have been studied in high exposure contexts (e.g., [60]), more research is needed on household capacities and vulnerabilities in areas where both households and authorities have little experience of disasters.

There is research evidence that individual psychological characteristics, such as risk perception and self-efficacy [24], as well as trust in authorities [45,59], and the perception of how responsibility for preparedness is usually distributed [24,59] influence individual preparedness behavior. Nevertheless, there is a lack of studies on whether these factors are more important than socioeconomic, demographic and place-based factors in low-vulnerability contexts. To carry out regional or national vulnerability evaluation and mapping, more generalizable ways of gathering knowledge are necessary.

In addition to individual and household capacities, governmental institutions are also vital in advancing disaster risk management and coping with natural hazards. This is especially true for the Nordic countries, where the public sector plays a significant role in disaster preparedness [35]. Municipalities are responsible for many preparedness and mitigation actions, such as emergency planning and maintaining resilient local infrastructure. Therefore, municipality finance is crucial to community preparedness, response and recovery [17]. At the same time, Oulahen et al. [33] suggest that especially non-vulnerable people do not consider institutional arrangements such as insurance schemes or authorities' preparedness and mitigation actions very important, and they may not recognize how much these arrangements reduce their personal risks. One additional viewpoint to consider is that maintaining a very ambitious societal preparedness level may be costly. In rural areas, storm impacts are often connected to trees damaging overhead power lines. For this reason, storm-related disruptions have been prevented by extensive underground cabling of power lines in some areas. However, it has been shown that in Finland's rural areas this solution is not cost-effective, and it can be deemed as over-adaptation [61].

This study illustrates that different types of vulnerabilities must be recognized. Because storm experiences and vulnerability differ according to an individual's area and type of residence, communication about preparedness needs to be more targeted. For example, it could be beneficial to aim some of the communication specifically at city dwellers. They have less experience of storm-related disruptions, and therefore they may have an excessive sense of security regarding the reliability of electricity and telecommunications infrastructures. At the same time, the functioning of urban life is heavily dependent on these systems, and it is highly vulnerable if a rare large-scale disruption occurs.

There were some weaknesses in our study design. Firstly, the data collection method was not optimal: it was an open online questionnaire, which was disseminated through social media accounts of the Finnish Meteorological Institute and the Finnish National Rescue Association. Therefore, the distribution of respondents was not statistically representative, and could have affected some of the results; for example, the most vulnerable individuals may not respond to surveys. On the other hand, the Finnish Meteorological Institute is a valued organization, and its website has a large number of followers; this is also supported by the number of responses to the survey. Second, the sample was quite homogenous, reflecting the population in the area affected by the storm. For example, the number of single parents and unemployed people were too small to be properly analyzed. Third, not all potentially relevant factors were included in the survey: for instance, income, health, foreign background, social networks and risk perception could have offered more insight into the research topic. Furthermore, focusing on households and individuals is a limited approach: Ghanem et al. [58] note that assistance and information provision often happens on neighborhood level. Someone who seems particularly vulnerable on paper may get assistance from neighbors, friends and relatives. This leads back to the idea that vulnerability is not only a characteristic of an individual, but a community, and that social capital and networks are crucial for building community resilience [34].

6. Conclusions

According to this study, socioeconomic factors seem to have limited influence on storm preparedness or experienced impacts in Finland. Instead, having earlier experience of storm impacts and prior information increased the likelihood to prepare. In addition, some demographic factors, as well as respondents' dwelling type and residential area are connected to their storm experiences; respondents living in detached houses are more likely to receive prior information on the storm and prepare for it than respondents living in row houses or apartment buildings, and respondents in rural areas are more likely to experience damage than respondents in urban areas. Respondents' primary language is also connected to their storm experiences: those who answered the survey in Swedish were less likely to receive prior information on the storm and to take preparedness measures than those who answered in Finnish. Furthermore, respondents' age and gender influenced their storm experiences somewhat, but education level and employment status did not.

Our results question whether common climate risk and vulnerability assessment approaches are valid in low-vulnerability context. The assessments are typically based on socio-economic indices, but our results suggest that socioeconomic factors are not specifically linked to vulnerability in Finland. Furthermore, the goodness-of-fit of our statistical models were low suggesting that there are other significant factors that may explain storm preparedness and experienced harm. Therefore, we conclude by stressing that further research is needed to identify the relevant factors in equal low-vulnerability societies.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2021.102089.

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